

# MuSES BRDF VW&A

## First Phase

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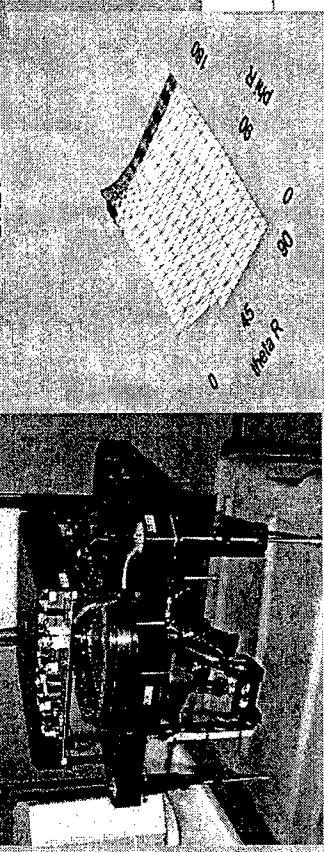
# MASTER PLAN



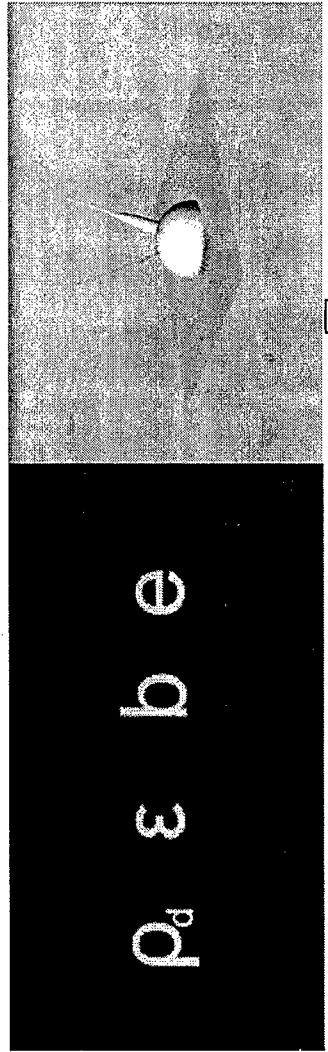
- OBJECTIVES
- BIG PICTURE
- BRDF
- SANDFORD-ROBERTSON
- TEST SETUP
- RESULTS
- LIMITATIONS AND RECOMMENDATIONS
- FUTURE PLANS

# The Big Picture

BRDF

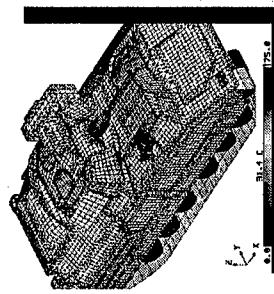
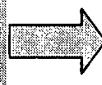


BRDF measurements



$$\rho_d \epsilon b e$$

Sandford-Robertson parameters



Physical modeling

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# OBJECTIVE



- Enhance the already existing MuSES Vv&A with validation of the BRDF Algorithms

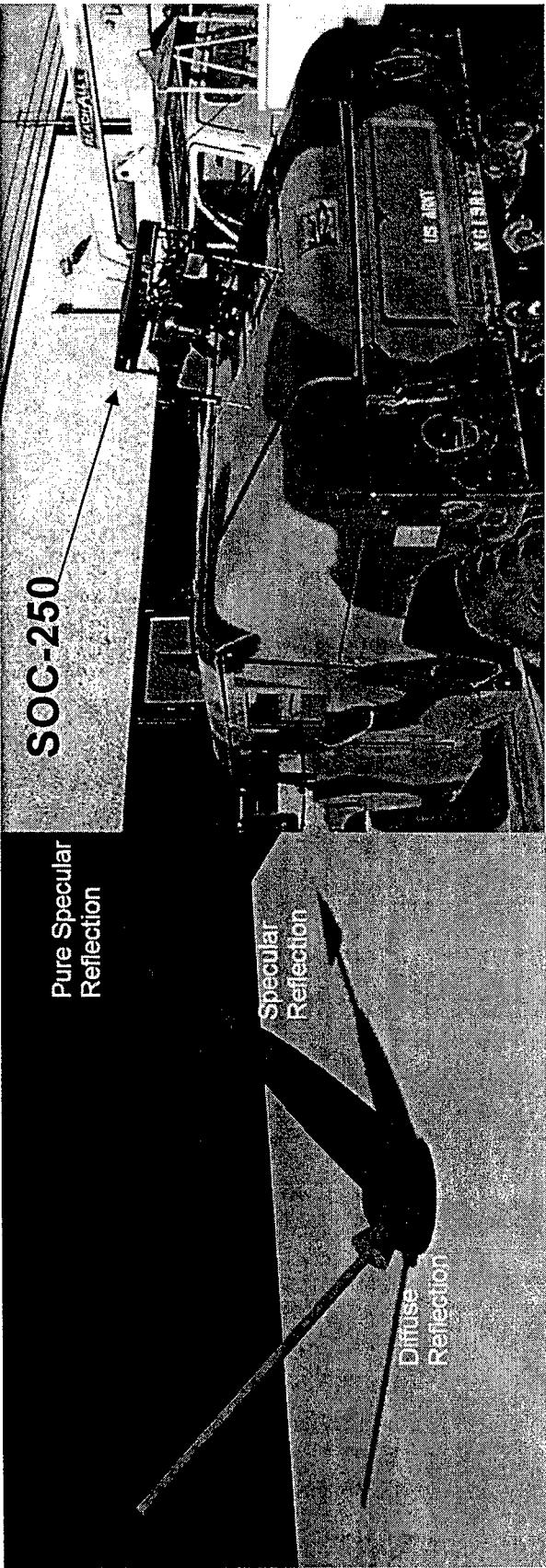


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# BRDF



A measure of the reflective properties  
of a material (i.e. diffuse, specular,  
semi-specular, etc.)



# SANDFORD-ROBERTSON



## ■ 4 Parameter Model

- $b$
- $e$

Constant for a given surface

- $\rho_D(\lambda)$
- $\epsilon(\lambda)$

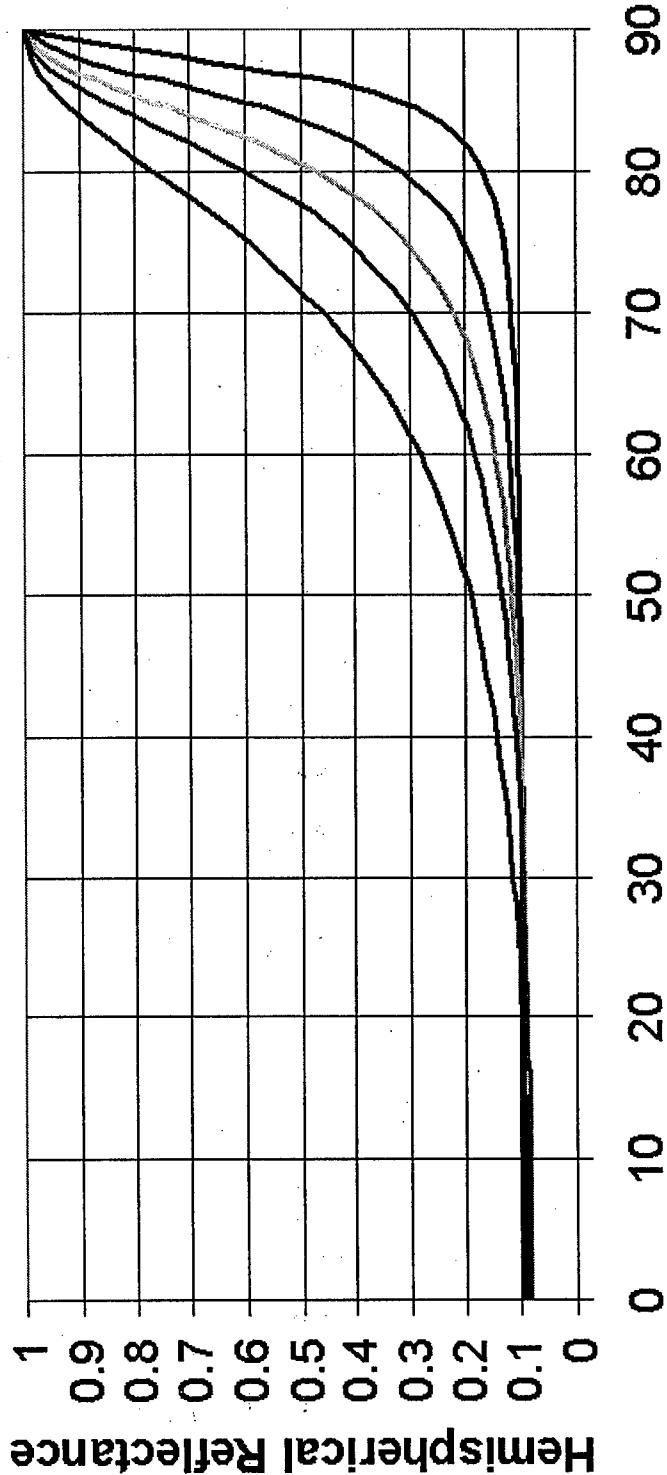
## ■ Estimation

## ■ Assumptions

- Ideal Specular Lobe
- $b$  and  $e$  are not  $\lambda$  dependent

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# SANDFORD-ROBERTSON PARAMETER "b"



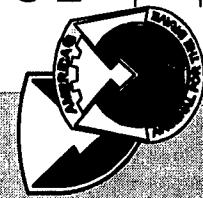
Incident Zenith [degrees]

$- b=0.05$  —  $b=0.10$  —  $b=0.15$  —  $b=0.20$  —  $b=0.30$

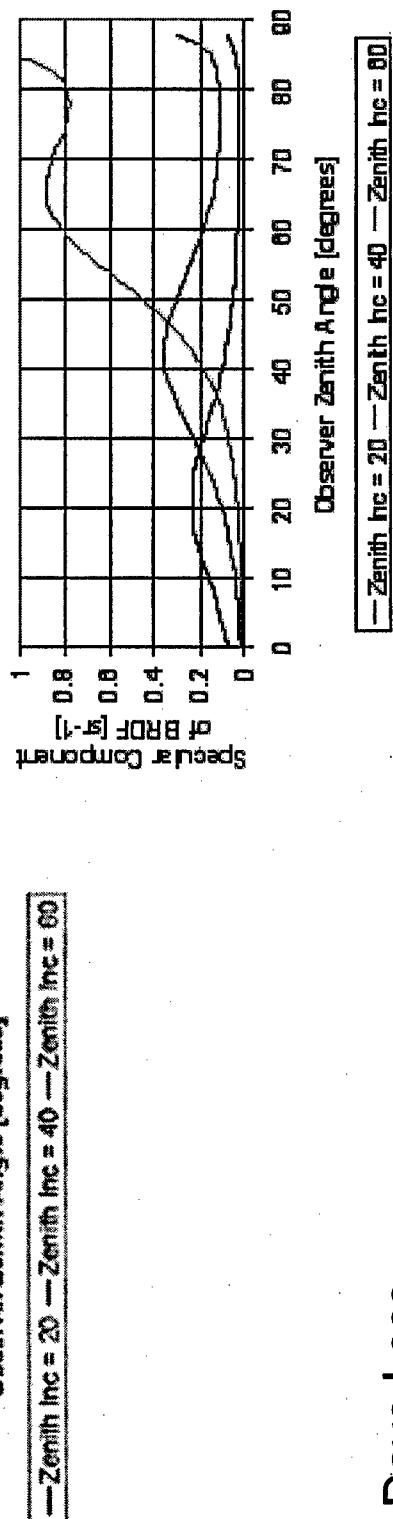
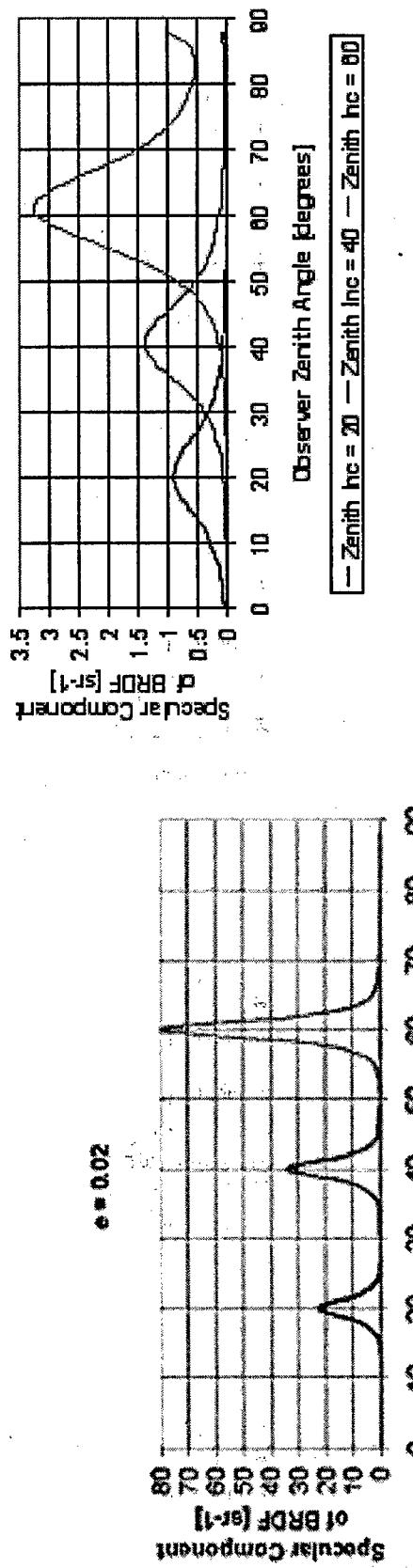
Courtesy of Dave Less, ThermoAnalytics

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# SANDFORD-ROBERTSON PARAMETERS "e",



## SANDFORD-ROBERTSON



Courtesy of Dave Less

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# CREATION OF MODELED DATA

make\_sr1 RE, 8/03

Sandford-Robertson Parameters

CARC Green @ 555nm

CARC Tan @ 555nm

Army Black @ 555nm

Army White Primer @ 555nm

Arbitrary [type in]

3-D View [someday]

Parameter Values

$\rho_0$	<input type="text" value="0.6410"/>	$\epsilon$	<input type="text" value="0.0500"/>	$b$	<input type="text" value="0.1000"/>	$c$	<input type="text" value="0.3500"/>
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Theta Incident (elevation)

$\Theta$	<input type="text" value="45"/>	$\Phi$	<input type="text" value="0"/>
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full hemisphere

floor

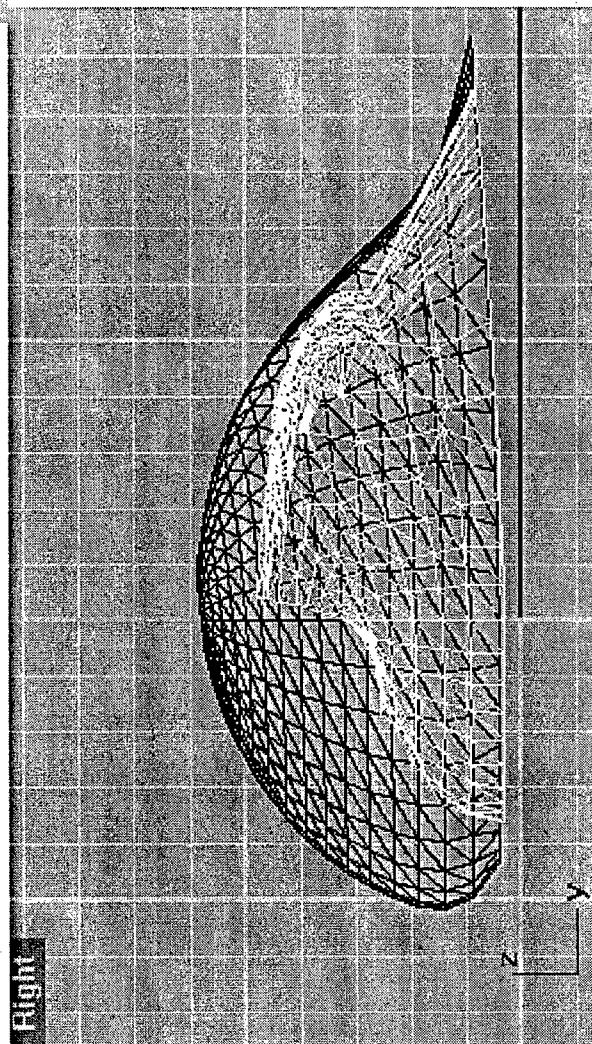
axes

Write RAW mesh

Write Phi=180 Values

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# COMPARISON- REAL VS. S-R MODEL



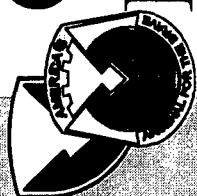
## ■ Pros

- Smoothes Data
- No Interpolation Necessary
- Totally Hemispherical

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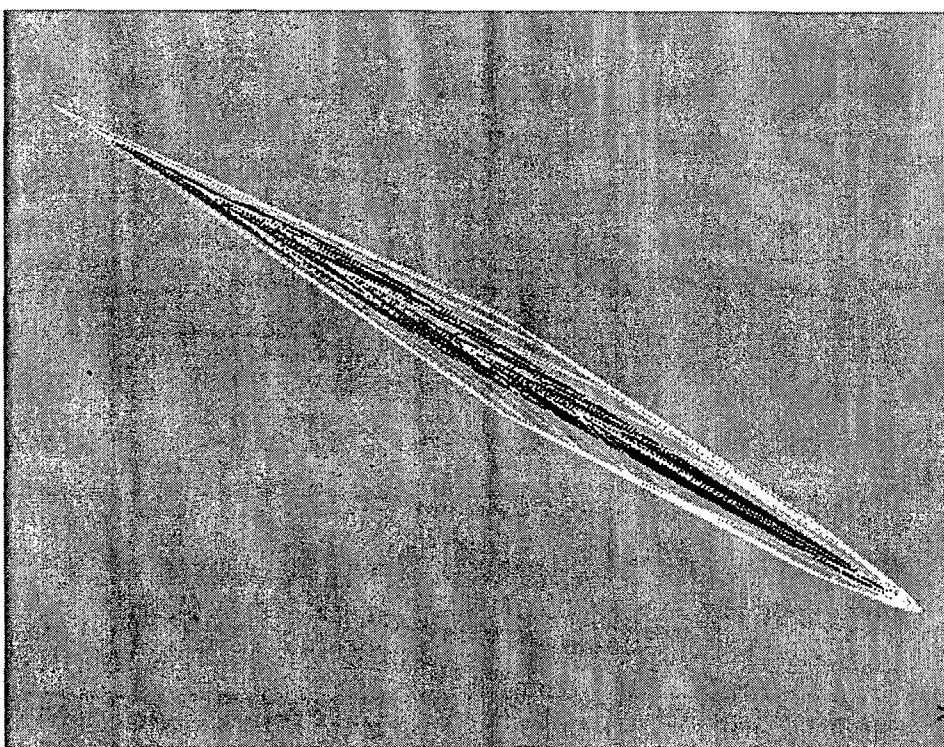


# COMPARISON- REAL VS. S-R MODEL

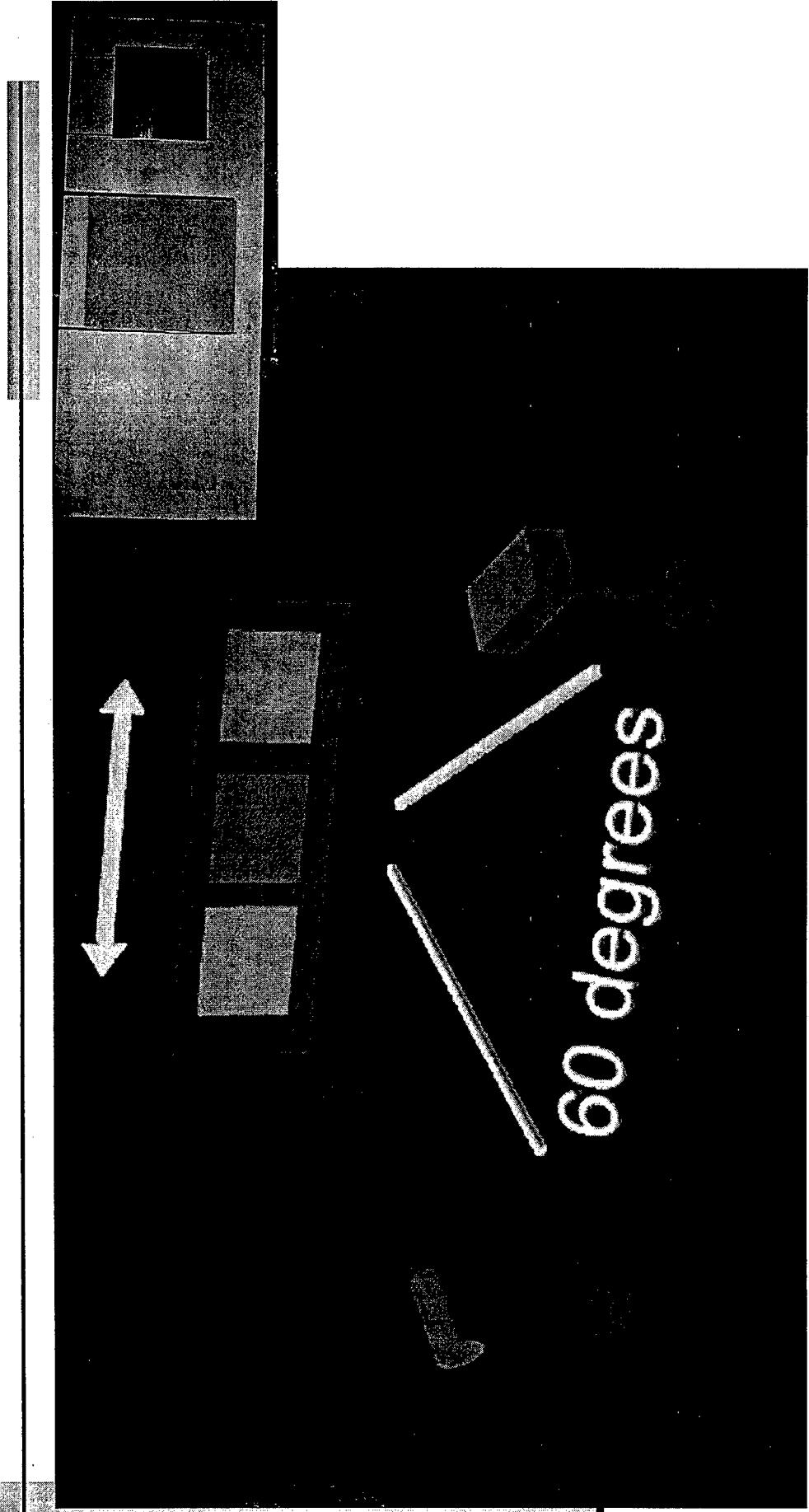


## ■ Cons

- Can't model atypical BRDF's or anisotropic materials
- Uses Theoretical Calculations (i.e. angle of incidence equals angle of reflection)

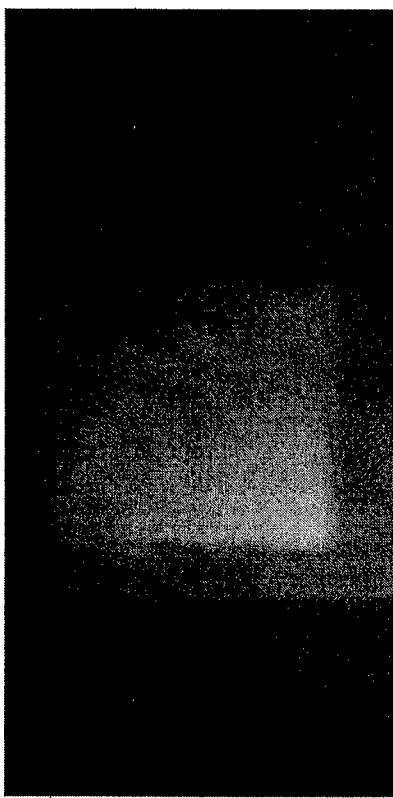
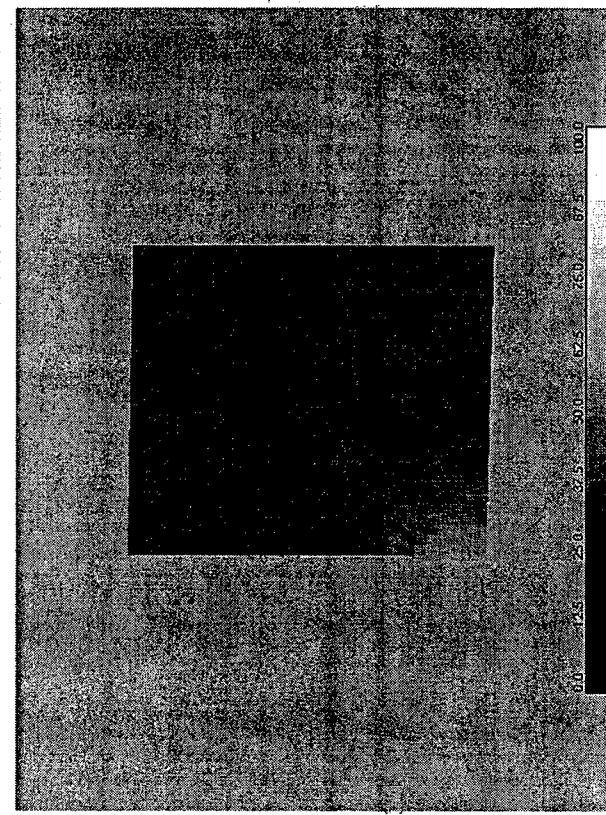


# TEST SET UP

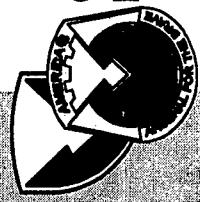


# DIFFUSE RESULTS

- Similar Properties
- Modeled Data is  $10W/m^2$  off
- Must use Weather file
- Must use Paint option

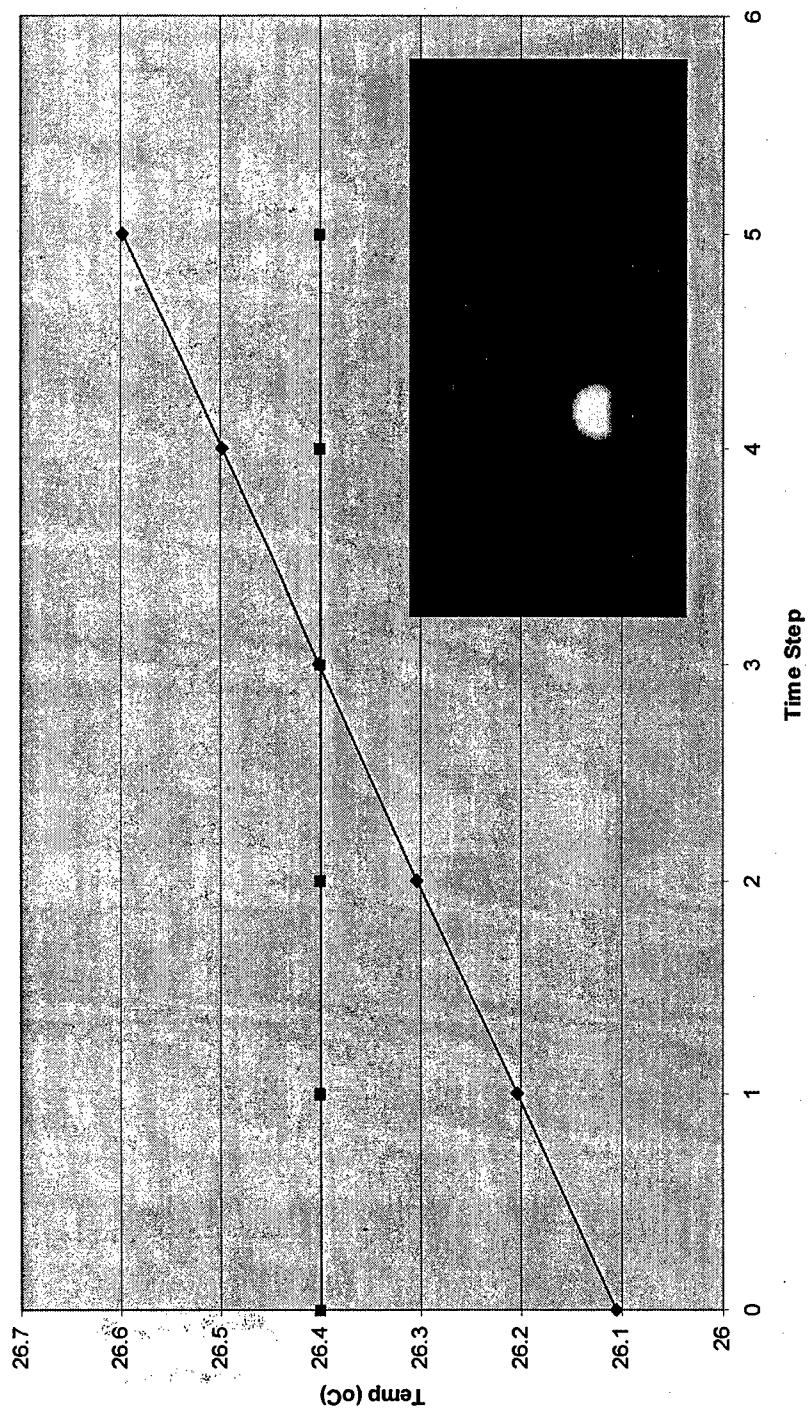


# SPECULAR DATA



Physical Temp Comparison (Polished Plate)

—◆— MuSES —■— Actual



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# LIMITATIONS AND RECOMMENDATIONS

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## ■ LIMITATIONS

### ■ Sandford-Robertson 4 Parameter Model

- Does Not Allow for Irregular Surfaces
- Disregards the Wavelength Dependence for Surface Properties

## ■ RECOMMENDATIONS

- Integrate User Defined Raw Data BRDF Parameters

# FUTURE PLANS

- Other Geometrical Shapes for Further Validation
- Environmental Exposure
- Variety of BRDF Panels

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## OPSEC REVIEW CERTIFICATION

(AR 530-1, Operations Security)

I am aware that there is foreign intelligence interest in open source publications. I have sufficient technical expertise in the subject matter of this paper to make a determination that the net benefit of this public release outweighs any potential damage.

Reviewer: Wallace R. Mick Jr. GS14 Mechanical Engineer

Name	Grade	Title
<u>Wallace R. Mick Jr.</u>		<u>2 Sep 03</u>
Signature		Date

## Description of Information Reviewed:

Title: MuSES Brdf VV&A First PhaseAuthor/Originator(s): Alicia Garth, Erik Polsen and Roger EvansPublication/Presentation/Release Date: G-VSS Conference - Aug 2003Purpose of Release: Conference

An abstract, summary, or copy of the information reviewed is available for review.

## Reviewer's Determination (check one)

1. Unclassified Unlimited. *This presentation contains no military information. The content is routine physics applied to surface reflectance characteristics. I see no problem with unclassified unlimited release. Wally Mick*

2. Unclassified Limited, Dissemination Restrictions IAW \_\_\_\_\_

3. Classified. Cannot be released, and requires classification and control at the level of \_\_\_\_\_

## Security Office (AMSTA-CM-XS):

Concur/Nonconcur

John Reynolds

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4 Sep 03

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